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(54) METHOD AND DEVICE FOR HOT SHAPING THERMOPLASTS

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(56) Documents taken into consideration in the evaluation of the patentability:
DE 38 23 670 A1
EP 06 40 455 A1

DE-Z: Kunststoffe 86/1996/8, pp. 1114-1118;

DE-Z: Kunststoffe-Plastics, Vol. 31, 1984, H. 8, pp. 20-22;

DE-Z: Kautschuk + Gummi, Kunststoffe, Vol. 36, No. 10/1983, pp. 899-901;

(57) Abstract

Method for hot shaping thermoplasts, wherein a blank, pre-form, or similar semi-finished material is heated to the shaping temperature and is shaped by means of a shaping [molding] device, in particular a blow (stretch) [injection molding] installation, a deep-draw installation, or a similar molding tool, and wherein the blank is exposed to radiation of defined intensity from a source, whose radiation presents an intensity maximum in an emission wavelength within the infrared range, and wherein the radiation is passed over the surface of the blank with the distribution in the blank being such that a defined temperature profile is produced along its surface, characterized in that the emission wavelength range is 0.8-1.0 μm.

Description

[0001]

The invention relates to a method and a device for hot shaping thermoplasts according to the preamble of Claim 1 or the preamble of Claim 9.

[0002]

Such a method and device are known from EP 0 640 455 A1.

[0003]

In such methods or devices, it is particularly essential that the blank presents a temperature profile that is suitable for shaping, and is adapted to the final product to be manufactured. Such a temperature profile, if the shapes of the product are complicated, in particular if small wall thicknesses are desired, can be relatively complicated or it can be highly nonhomogeneous over the circumferential surface of surface of the mold body. However, a nearly constant temperature is desired for the entire wall thickness, that is, the "depth" of the blank. To achieve this, one works, in particular, with hot air sources or with infrared radiation emitters, and in many cases with heated molds that are used in several steps (for example, for deep drawing). Here the heat can be applied nearly exclusively onto the surface of the blank so that, to achieve the constant temperature in the interior of the material, that is, through its wall thickness, one must have recourse to heat transport by heat conduction inside the material. This heat transport in turn requires a relatively slow heating or [sic; long] residence times, within which the temperature compensation (throughout the depth of the material) can take place. As a result, methods and devices of the type mentioned above become expensive and subject to breakdown. In particular, the setting of an appropriate temperature profile over the spatial extent of the blank is decidedly difficult.

[0004]

The invention is based on the problem of improving a method and device of the type mentioned above in such a manner that it is possible to achieve a simplified heating of the blank, with improved temperature precision.

[0005]

This problem is solved by a method according to Claim 1 or a device according to Claim 9, respectively.

[0006]

Here, the intensity maximum is in the near infrared range, namely at 0.8-1.0 μm, that is, in a wavelength range that is considerably shorter than the wavelengths at which the intensity maximum occurs with conventional heat radiation sources. It is preferred to achieve not only a considerably more homogeneous heating of the blank at depth, but also a considerably faster heating. If a heat radiation emitting device is used, which presents an at least essentially

continuous radiation spectrum, the result is that, at the setting of the intensity maximum proposed here, namely at shorter wavelengths, the radiation intensity increases proportionally to approximately the 4th power of the temperature of the radiation emitting device.

[0007]

It is preferred to guide the radiation by means of optical installations, in particular mirrors, gratings, or similar installations of radiation optics to achieve a distribution on the blank such that a temperature profile that is adapted to the molding installation is set within the blank after the elapse of a defined period of time. Thus, it is not the radiation source that is set or modified, for example, by the application of energy. Instead, the application of energy applied to the blank is "set" as a function of the requirements. It is advantageous here for the radiation to have an intensity maximum in the above mentioned wavelength range, so that the conventional means of radiation optics can be used.

[0008]

It is particularly preferred to apply a radiation flow density of more than 0.5 MW/m^2, in particular more than 1 MW/m^2, onto the objects or blanks to be heated.

[0009]

It is preferred to set the wavelength of the intensity maximum by a setting, in particular by a regulation (that is, measurement and feedback of the relevant radiation parameters), of the temperature of a heating element. It is particularly preferred here to set the coil temperature of a halogen lamp. After the latter had to be adjusted to relatively high temperatures, which are unusual for halogen lamps (to achieve the mentioned short wavelengths), it is preferred to take corresponding measures to nevertheless ensure a long service life for the halogen lamps used. In particular, special cooling measures are taken for this purpose, both in the area of the (quartz) glass body and in the area of the base of the halogen lamps.

[0010]

In order to then set the intensity in accordance with the requirements, it is preferred to alternatively or cumulatively use the separation between the radiation source and the blank and/or an optical filter device, such as gratings or gray filters or similar parts and/or chopper devices.

[0011]

In the commercially particularly advantageous field of application of the method, which is the manufacture of polyethylene bottles, it is preferred to proceed in such a manner that the defined heating or radiation time essentially does not exceed 10 sec, and particularly advantageously 5 sec. As a result, on the one hand, one ensures a regular heating of the conventional blanks or pre-forms; on the other hand, the production rate is sufficiently high.

[0012]

The perform is preferably transferred immediately after the application of the radiation, without a long radiation-free residence time, onto the molding tool, in particular a blow-stretch installation, for shaping. As a result, one ensures that the temperature profile that is set (in particular by optics) along the body cannot be changed by heat conduction within the pre-form.

[0013]

For the manufacture of deep drawn parts it is preferred for the blank to be shaped without a significant heat contribution [transfer] from the tool to the blank. In particular, this can be achieved by shaping the blank in a single draw process. Consequently, one guarantees that the temperature profiles that have been set (in particular by optical means) in the blank are essentially maintained, avoiding the risk of sticking the blank to the deep draw tool, a risk that is encountered in particular with deep draw tools in which the heating of the blank occurs by means of the tool itself.

[0014]

The device thus consists of a radiation source with means for regulating the emission wavelength range of the radiation source in such a manner that the intensity maximum of the radiation source is in a wavelength range within which the thermoplast absorbs and allows the passage of, or penetration of, incident or impacting radiation with a lower degree of absorption, or a higher degree of transmission, than at higher wavelengths. The radiation source is preferably designed in such a manner that its intensity maximum is in the near infrared, range namely at 0.8-1.0 μm. The degree of absorption should be sufficiently low here, or the degree of transmission should be sufficiently high, so that the penetration depth for the radiation is guaranteed to correspond to the thickness of the blank to be processed, so that the blank is not heated only on its surface but, from the beginning on (that is, without heat compensation via heat conduction), in its interior.

[0015]

It is preferred to provide mirrors, gratings, or similar installations of radiation optics to heat the blank with a temperature profile that is optimal for the shaping.

[0016]

As far as the halogen lamp, which is preferably provided as a radiation source, or as far as a similar radiation installation with a heating element, is concerned, it is preferred to use, for regulating the coil temperature, a current regulator that maintains the level determined by a correspondingly designed sensor (pyrometer), in order to keep the coil temperature or the wavelength range in which the intensity maximum of the radiation source is located, at a constant level and to set it in accordance with the above-mentioned requirements.

[0017]

Furthermore, the intensity is also regulated (by disturbance feed-forward control or by means of a comparison of the desired and actual values) so that, within the set time of exposure to radiation, the desired temperature profile is reached. This intensity setting can be carried out by means of the separation between the radiation source and the blank and/or by optical filter devices and/or a chopper device, which allow, in a manner of speaking, "radiation packets" to reach the blank, where the chopper rate is chosen in such a manner that the "package durations" are very short compared to the overall period of time over which energy is applied to the blank.

[0018]

In the manufacture of PET bottles, the arrangement is chosen in such a manner that the blank is brought within the range of the radiation source for a period of less than 10 sec, preferably less than 5 sec, then removed from this area again, so that no substantial temperature compensation can occur with modification of the temperature profile that has been set (by optical installations). In addition, or alternatively, one can also design the entire device for the manufacture of PET bottles with the use of stations (radiation source, molding tool) that are located close to each other and equipped with conveyor installations in such a manner that there is no long residence time of the blank or pre-form during which radiation energy can occur, resulting in heating before the shaping in the blow-stretch installation. As a result, the set temperature profile is maintained in the pre-form.

[0019]

In the manufacture of deep drawn parts, a deep draw tool is used, having a relatively low temperature (compared to the deep draw tools used to date), where it is preferred to use a single deep-draw tool and thus to shape the blank in a single deep-draw process. Here too the advantage is that no substantial modification of the temperature profile occurs, which has been set beforehand by the appropriate addition of radiation energy.

Claims

1. Method for hot shaping thermoplasts, wherein a blank, pre-form, or similar semi-finished material is heated to the shaping temperature and shaped by means of a shaping [molding] device, in particular a blow (stretch) installation, a deep draw installation, or a similar molding tool, and wherein the blank is exposed to radiation of defined intensity from a source whose radiation presents an intensity maximum in an emission wavelength within the infrared range, and wherein the radiation is passed over the surface of the blank with the distribution in the blank being such that a defined temperature profile is produced along its surface, characterized in that the emission wavelength range is 0.8-1.0 µm.

2. Method according to Claim 1, characterized in that the radiation is applied by means of optical devices, in particular mirrors, gratings or similar devices of radiation optics onto the blank with a distribution such that a temperature profile, which is adapted to the molding device, is set within the blank after the elapse of a defined period of time.

3. Method according to Claim 1 or 2, characterized in that the wavelength of the intensity maximum is set by regulating the temperature of the radiation source.

4. Method according to one of Claims 1-3, characterized in that the intensity of the device is set, in particular by the regulation of the separation between the radiation source and the blank and/or an optical filter device, such as a grating and/or gray filter and/or by a chopper device.

5. Method according to one of Claims 1-4 for the manufacture of PET bottles, characterized in that the blank is exposed to radiation for a period no longer than 10 sec, preferably no longer than 5 sec.

6. Method according to Claim 5, characterized in that the blank is essentially shaped immediately after the exposure to the radiation without a long radiation-free residence time in the molding tool, in particular in a blow-stretch installation.

7. Method according to one of Claims 1-5 for the manufacture of deep drawn parts, characterized in that the blank is shaped without substantial heat addition from the tool to the blank.

8. Method according to Claim 7, characterized in that the blank is shaped in a single draw process.

9. Method for hot shaping thermoplasts, consisting of a heat addition device, for heating a blank, pre-form, or similar semi-finished material to the shaping temperature, and a molding device, in particular a blow (stretch) installation, a deep draw installation, or a similar molding tool for shaping the heat blank, where:

the heating device consists of a radiation source equipped with a regulation device for regulating the emission spectrum of the radiation source in such a manner that the intensity maximum of the radiation source is within the infrared range,

with a radiation-optical deflection device being provided for deflecting at least a part of the emitted radiation of the radiation source in the direction of a defined area of the blank surface, in order to set a defined temperature profile along the blank surface

characterized in that the intensity maximum is in the emission wavelength range of 0.8-1.0 μm.

10. Device according to Claim 9, characterized in that the radiation source consists of a halogen lamp or similar radiation device with a heating element and in that the regulation consists of a current regulator to set and regulate the temperature of the radiation device, in particular a coil of the halogen lamp.

11. Device according to Claim 10, characterized in that a cooling device is provided, to cool the foundation of the radiation device.

12. Device according to one of Claims 9-11, characterized in that an intensity regulation device is provided for the regulation of the intensity of the energy applied to the blank, with such an intensity regulation device consisting of a separation setting device for setting the separation between the radiation source and the blank and/or an optical filter device, such as a grating or gray filter and/or chopper devices.

13. Device according to one of Claims 9-12 for the manufacture of PET bottles, characterized by a time setting device, which is designed in such a manner that radiation of a defined intensity can be applied to the blank over a predefined period of time, which essentially does not exceed 10 sec, preferably 5 sec.

14. Device according to one of Claims 9-13 for the manufacture of PET bottles, characterized in that the radiation source is installed within an essentially continuously operating production line practically immediately in front of the molding device in such a manner that the pre-form is essentially shaped immediately after the application of the radiation without a long radiation-free residence time in the molding tool, in particular in a blow-stretch installation.

15. Device according to one of Claims 9-12 for manufacturing deep drawn parts, characterized in that the molding device is designed so that it is essentially not heated and the blank can be shaped from the material without a great amount of heat for increasing the temperature.

16. Device according to Claim 15, characterized in that a single deep drawn tool is provided.

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